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ABSTRACT

Underlying structure of the Basic Achievement Skills Individual Screener (BASIS) and the Kaufman Test of Educational Achievement (K-TEA) were investigated using canonical correlation. Both are individually administered placement and screening instruments currently in use in many school systems that measure achievement in mathematics, reading, and spelling. The sample consisted of 61 elementary-aged underachievers in grades 1 through 8 who were referred for assessment because of learning problems. It was expected that scores on the two tests which purport to measure spelling, reading, and mathematics would be identified with separate canonical dimensions, thus demonstrating the existence of independent underlying constructs which fit hypothesized test structures. Results revealed three significant canonical variates. The first canonical root appeared to measure a verbal achievement dimension, while the second and the third roots assessed mathematics and overall achievement, respectively. The three variates were found to load on more than one variate. These findings suggested that the underlying structure of the two tests was essentially unidimensional among the restricted sample of subjects used in this study. (Author/RR)

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STRUCTURAL ANALYSIS OF THE BASIS AND K-TEA

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Underlying structure of the Basic Achievement Skills Individual Screener (BASIS) and the Kaufman Test of Educational Achievement (K-TEA) were investigated using canonical correlation. Both instruments were published within the last four years; are individually administered placement and screening instruments currently in use in many school systems; and provide various tasks measuring achievement in mathematics, reading, and spelling. The sample consisted of 61 elementary-aged underachievers. It was expected that scores on the two tests which purport to measure spelling, reading, and mathematics would be identified with separate canonical dimensions, thus demonstrating the existence of independent underlying constructs which fit hypothesized test structures.

Statistics associated with three canonical variates were found to be statistically significant at the .01 level of confidence. Standardized canonical correlation coefficients associated with the canonical variates showed that the first canonical root appeared to measure a verbal achievement dimension, while the second and the third roots assessed mathematics and overall achievement, respectively. The three variates were found to load on more than one variate. These findings suggest that the underlying structure of the two tests is essentially unidimensional among the restricted sample of subjects used in this study.

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INTRODUCTION AND REVIEW OF THE LITERATURE

In this study, underlying structure of the Basic Achievement Skills Individual Screener (BASIS) and the Kaufman Test of Educational Achievement (K-TEA) were investigated using canonical correlation. Both tests are individually administered achievement tests; provide various subtest scores reflecting student achievement in mathematics, reading, and spelling; and have become available recently. The BASIS (1983) and the K-TEA (1985) were released recently, and very little research has been conducted on these instruments. Since both instruments are currently in use in many school systems, further study of the BASIS and the K-TEA is warranted.

The BASIS assesses skill in reading, mathematics, spelling, and written expression. Normative scores are obtained for pupils in grades 1-12 and post-high school. Norm-referenced scores are reported in grade and age equivalents, standard scores, stanines, percentiles, and normal curve equivalents. Criterion-referenced information is obtained through an analysis of groups of test items and is designed to reflect the sequential order of difficulty in which material is usually presented in the classroom. The BASIS is intended to provide a first-step diagnostic assessment in the placement of new students; to determine the need for additional diagnostic testing; and to help plan, evaluate and select programs, research, and the placement of entry-level employees in industry (Basic Achievement Skills Individual Screener-BASIS, 1983).

The BASIS was developed in 1983, and test reviews have been favorable overall. Ysseldyke (1985) reported that the test is technically adequate while Conley (1986) concluded that although the BASIS is intended for grades one through post-high school, it probably should not be used beyond the eighth grade because content does not adequately reflect high school curricula. A review by Hambleton and deVries (1985) challenged the quality of the normative information on the grounds that the norm groups were too small to be valid. These authors also felt that diagnostic usefulness of the battery is limited because too few test items are provided for each grade level. Additionally, they were critical of administration procedures and reported that the manual is poorly organized and repetitious. Radencich (1985) also found administration procedures to be somewhat unsatisfactory but recommended cautious use of the BASIS. She reported that positive features of the instrument

include an easy to read manual, proper norming procedures, and a sound rationale for item selection.

The K-TEA was designed to provide norm-referenced and criterion-referenced information on reading, mathematics, and spelling achievement for children ages 6 to 18. The K-TEA Comprehensive Form includes five subtests: mathematics applications, reading decoding, spelling, reading comprehension, and mathematics computation. A reading composite, a mathematics composite, and a battery composite can be calculated from the subtest scores, and an error analysis can be performed. Test results may be reported in standard scores, stanines, percentile ranks, and age and grade equivalents. The K-TEA was designed to be used in educational, psychological, or neural evaluation of students; assessment of students strengths and weaknesses; educational placement of students; evaluation of children for special services; and acquisition of data for research purposes (Kaufman & Kaufman, 1985).

In a review of the K-TEA, Radencich (1986) reported that the instrument is well-constructed and predicted widespread acceptance. Particular strengths noted were norms for both fall and spring, a useful parent report form, an item analysis procedure, and general technical sophistication. Reported weaknesses were that possible item bias was not considered for ethnic groups other than blacks and whites and that grade cluster scores were not included. In the opinion of Radencich, grade cluster scores would be useful since "grade equivalents could be interpreted as grade level performance as occurs with the BASIS" (p. 621). Lewandowski (1986) reported that the K-TEA is a state of the art test. He found the K-TEA to be a well-conceived instrument which is "based on research and theory emanating from cognitive psychology, reading and linguistics" (p. 261). He commended the instrument's procedures, excellent construction, standardization procedures, statistical content, conceptual framework, and method for error analysis which identifies strengths and weaknesses within achievement areas. Test limitations noted were the lack of sensitivity at the age extremes (under 6 years old and over 17 years old) and the presumed ability of the K-TEA to measure the corresponding skill catagory which underlies a given achievement area. In his opinion the manual provides insufficient support for the contention that the test measures underlying skills, although he suggested that future research might provide such evidence.

In Test Critiques, Volume 5, Henson and Bennett (1986) also found the K-TEA to be a well-constructed instrument and recommended its use in the field of educational assessment. They reported that the test is easy to use and well-written, the manual is detailed, norming data is excellent, and reliability and validity data are fully reported. They recommended the K-TEA as a useful instrument in evaluation

of school achievement of children in all grades and in special education.

In the present study scores of the BASIS and K-TEA were examined using canonical correlation. It was expected that K-TEA Reading Comprehension and Reading Decoding would predict BASIS Reading, K-TEA Spelling would predict BASIS Spelling, and K-TEA Mathematics Applications and Mathematics Computation would predict BASIS Mathematics, and that the resulting test dimensions would be relatively independent. Such findings would tend to support the contention that both tests are measuring common underlying verbal and quantitative dimensions.

METHOD

Subjects

The sample was composed of 61 students enrolled in a school system in northern Louisiana during the 1985-86 and 1986-87 academic years. The participants ranged from the first through the eighth grades. All of the students were referred to a local Pupil Appraisal Team for assessment because they were experiencing learning problems.

Instruments

The BASIS, which is published by the Psychological Corporation (1983), consists of subtests in spelling, mathematics, reading, and writing. The validity and reliability of the BASIS has been reported to be adequate in test reviews and in reported test norms (Conley, 1986; Radencich, 1985; Worthington, 1987; Ysseldyke, 1985). Specifically, concurrent validity of content scores was measured by correlating BASIS content scores and school grades. Correlations of .25 to .61 were judged by Hambleton and deVries (1985) to be adequate. Kuder-Richardson Formula 20 values ranged from .85 to .97, with most values being above .90, while test-retest reliability coefficients ranged from .81 to .96. The BASIS was standardized in the fall of 1982 on more than 3,200 students in grades 1 through 12.

The Mathematics Performance section consists entirely of computational problems with six computational problems and two word problems at each grade level. In order to insure that items reflect grade level the authors analyzed major textbook series, achievement tests, and curriculum-related materials. Content selection was made on the basis of those objectives which constitute the essence of each grade's curriculum. The error analysis is divided into four catagories: addition, subtraction, multiplication, and division. Again, grade and skill levels for performance within each catagory are specifically identified.

Reading Comprehension and Reading Readiness are the reading skills included in the BASIS. Comprehension is measured by using a modified cloze technique consisting of word deletions embedded in a story. The child must understand the passage in order to provide the missing words. There are two to six cloze items per reading grade level. The Reading Readiness Cluster consists of four items each of letter identification, visual discrimination, word reading, and sentence reading.

Spelling is measured by having the students spell six words at each grade-referenced cluster. The test is administered orally with each word pronounced as well as used in a simple sentence. The Writing Assessment subtest is a 10 minute optional subtest. The student is given a specific topic upon which to write a theme.

The K-TEA is an individually administered achievement measure developed by Kaufman and Kaufman (1985) and published by the American Guidance Service. The test yields five subtest scores and three composite scores. Both Comprehensive and Brief Forms of the K-TEA are available. The manual reports that the two versions of the test measure the same achievement areas but are made up of different items. Because no overlap in content exists, they are suggested for use in research requiring comparable forms of the same instrument.

Since the K-TEA is a new test, the only available reliability and validity coefficients are those obtained from test standardization procedures reported in the manual. Concurrent validity of the K-TEA was established in studies employing the Wide Range Achievement Test, Peabody Individual Achievement Test, Kaufman Assessment Battery for Children, Peabody Picture Vocabulary Test-Revised, Stanford Achievement Test, Metropolitan Achievement Test, and The Comprehensive Test of Basic Skills. The manual also reports that construct validity of the K-TEA is adequate. Split-half reliability coefficients measuring internal consistency generally exceed .90, while all test-retest reliability coefficients except that for Mathematics Computation ($\underline{r}$ =.83) are above .90. Test standardization procedures, which involved almost 2500 cases, are fully described.

There are 60 items in the Mathematics Applications Subtest. The items are administered orally and each item is accompanied by a visual stimulus. The skill categories underlying this subtest include elementary number concepts, addition, subtraction, multiplication, division, fractions, decimals, percentages, advanced number concepts, measurement, money, estimation, and two-step problems. The Mathematics Computation Subtest is made up of 60 problems solved in written form. The skill catagories covered by this subtest are basic addition and regrouping addition, basic subtraction and regrouping subtraction, multiplication, division, fractions, advanced addition and subtraction, algebraic equations, and square roots and exponents.

Achievement in reading is measured by two subtests, Reading Decoding and Reading Comprehension. Reading Decoding consists of 60 items designed to assess the ability to identify printed letters and word sounds. The skill categories in this test are prefixes and suffixes, closed and open syllables, vowel digraphs and diphthongs, controlled patterns, consonant patterns, consonant clusters and digraphs, and single and double consonants. Reading Comprehension consists of 50 sentences and short paragraphs followed by questions which must be answered by the student either by gesture--at primary grade levels--or orally for upper grade levels. The skill catagories measured are literal and inferential comprehension.

The Spelling Subtest contains 50 words which are orally presented by the examiner and used in a sentence. The child writes each word on a worksheet or, if there is difficulty in writing, spells the word orally. This subtest assesses the same skill categories as the Reading Decoding Subtest.

Procedure

Students were evaluated during the 1985-86 and 1986-87 academic years in compliance with Bulletin 1508 which lists the criteria for administration of special educational services rendered in Louisiana. The BASIS and the Comprehensive Form of the K-TEA were administered by qualified school system personnel. Data were analyzed using Pearson r and canonical correlation. In the canonical analysis K-TEA Mathematics Applications, Mathematics Computation, Reading Comprehension, Reading Decoding, and Spelling subtest scores were used to predict BASIS subtest scores in Reading Comprehension, Mathematics Performance, and Spelling. Since the K-TEA does not include a measure of writing skill, the BASIS Writing Assessment subtest was not included in the analysis.

Table 1

Pearson Product Moment Correlation Matrix, n = 61

	BASIS			K-TEA				
	Mathematics	Reading	Spelling	MA	MC	RD	RC	SP
BASIS								
Mathematics	1.00	.33**	.35**	.59**	.49**	.37**	.28*	.46**
Reading		1.00	.49**	.34**	.09	.62**	.46**	.31*
Spelling			1.00	.08	.09	.72**	.39**	.75**
K-TEA								
Mathematics Application (MA)				1.00	.55**	.28*	.35**	.19
Mathematics Computation (MC)					1.00	.33**	.37**	.33**
Reading Decoding (RD)						1.00	.69**	.75**
Reading Comprehension (RC)							1.00	.43**
Spelling (S)								1.00

*Statistically significant at the .05 level of confidence.

**Statistically significant at the .01 level of confidence.

Table II

Results of Canonical Correlation, $n = 54$

Tests of Overall Significance

Canonical Variates	Eigenvalue	Percent Variance	C_r	df	F-test
1	2.29	71	.87	15,127	12.23*
2	.84	18	.68	8,94	7.69*
3	.48	10	.57	3,48	7.75*

Canonical Coefficients for Variables Associated with Canonical Variates

Variable	Canonical Variates 1	2	3
BASIS			
Mathematics	.50	-.87	-.03
Reading	.68	-.08	-.73
Spelling	.97	.07	.23
K-TEA			
Mathematics Applications	.19	-.85	-.44
Mathematics Calculations	.14	-.77	.08
Reading Decoding	.90	.03	-.23
Reading Comprehension	.53	-.09	-.33
Spelling	.85	-.19	.47

*Statistically significant at the .01 level of confidence.

RESULTS

Pearson product moment correlation coefficients (r) among pairs of test scores are presented in Table I. In an ideal test intercorrelations between various subtest scores which measure unrelated constructs would be low, indicating such subtests are relatively independent. Intercorrelations between related subtests such as Mathematics Applications and Mathematics Computation would be high, thus showing that they tap aspects of the same basic underlying construct. As may be seen in Table 1, results of Pearson r for independent pairs of test scores were somewhat disappointing.

Correlations among the three BASIS scores are relatively modest although all three of the correlations were found to be statistically significant at the .01 level of confidence. Intercorrelations between Reading and Spelling (.49), which are subjects relying upon similar skills, were higher than correlations between Mathematics and Reading (.33) and Mathematics and Spelling (.35). Relatively high intercorrelations were obtained between K-TEA pairs of subtest scores which were expected to be related (K-TEA Reading Decoding with Reading Comprehension r = .69, K-TEA Mathematics Applications with Mathematics Computation r = .55). These subtests measure similar aspects of achievement. Likewise, the high intercorrelation between K-TEA Reading Decoding with Spelling (r = .75) may be explained in that both subtests measure verbal abilities. However, all but one (Mathematics Applications with Spelling r = .29) of the theoretically unrelated K-TEA intercorrelations were found to be statistically significant as were all intercorrelations between theoretically unrelated BASIS subtests.

Similar findings were obtained for intercorrelations between BASIS and K-TEA subtests. Specifically, as expected, BASIS Mathematics was found to be related to both K-TEA mathematics scores (r = .59 and .49), BASIS Reading to K-TEA reading scores (r = .62 and .46), and BASIS Spelling to K-TEA Spelling (r = .75). However, virtually all other intercorrelations between pairs of theoretically unrelated subtests were found to be statistically significant. Only three correlations were not found to be statistically significant (BASIS Spelling with K-TEA Mathematics Applications r = .08, Basis Reading with K-TEA Mathematics Computation r = .09, and Basis Spelling with K-TEA Mathematic Computation r = .09).

Canonical correlation was employed in order to examine underlying structure of the BASIS and K-TEA further. Canonical correlation is an extension of multiple regression which permits prediction of one set of variables from knowledge of another. In the present study, BASIS

subtest scores in Mathematics, Reading, and Spelling were used to predict K-TEA subtests in similar areas of achievement. Use of this statistic amplifies information obtained from study of correlations between individual variable pairs in that it establishes the relationship between sets of variables. In addition to providing statistics which assess both statistical significance and substantive value of canonical roots (or variates), relationships between individual variables in both variable sets and canonical variates are produced. Canonical variates are interpreted in a similar manner to factors in factor analysis and thus permit identification of underlying test constructs through analysis of item loadings associated with each canonical variate.

As may be seen in Table II, three canonical roots calculated were found to be statistically significant at the .01 level of significance. In addition, the canonical correlations associated with each of these three roots were impressive, indicating that results were substantive in addition to being statistically significant, Variate 1, C_r =.87, F = 12.23, p <.01; Variate 2, C_r = .68, F = 7.69, p <.01; Variate 3, C_r = .57, F = 7.75, p <.01. Since the first variate accounts for over 70% of the variance, the other two variates appear to be negligible even though the F test calculated on the canonical correlation indicates statistical significance was obtained.

Of perhaps greater interest is the portion of Table 2 which presents canonical coefficients for sets of independent and dependent variables. The first root appeared to measure verbal achievement primarily since all three K-TEA verbal subtests were associated with this root as were both BASIS verbal subtests. The second variate obviously measured mathematics. Both K-TEA mathematics subtests (coefficients -.85 and -.77) and the BASIS Mathematics subtest (coefficient -.87) were identified closely with it. Note, however, that inexplicably the BASIS mathematics subtest also loaded with the first verbal achievement root (coefficient = .50). The third root was a bipolar overall achievement dimension with BASIS Reading (coefficient = -.73), K-TEA Mathematics Applications (coefficient = -.44), and K-TEA Reading Comprehension (coefficient = -.33) at one polarity and Spelling (coefficient = .47) at the other.

DISCUSSION

Results of Pearson *r* analyses show that, as expected, mathematics subtests, reading subtests, and spelling subtests of the two tests appear to be related to each other. However, correlations between subtest variables which are conceptually independent for both tests also are intercorrelated to a moderate degree. These findings suggest that, while the two tests are measuring the same skills, the underlying independent structure of the two tests is suspect.

This finding was confirmed by results of canonical analysis. Although as expected, three statistically significant canonical variates were derived, instead of measuring separate independent mathematics, reading, and spelling dimensions, the results strongly suggest that the two tests primarily measure one important verbal achievement factor with the two weaker variates measuring mathematics and overall achievement. Supporting the contention of one primary factor is the fact that considerable overlap between variates was present; for example, K-TEA Mathematics Applications, K-TEA Spelling, K-TEA Reading Comprehension, Basis Mathematics, and Basis Spelling have coefficients which exceed ± .30 on more than one variate.

Such overlap is an indication that--even though three statistically significant canonical roots were calculated, each with a moderately substantive correlation term--the variates are not truly independent. Of considerable interest in view of these findings is the amount of variance associated with the eigenvalue of the first root (71%) as well as the fact that all but two (K-TEA Mathematics Applications and K-TEA Mathematics Computations of the eight variables) used in the canonical analysis loaded with the first root. Of the other two variates, the first variate measures mathematics; the second variate measures overall achievement. Both are relatively weak with the latter factor being so confusing that it is virtually uninterpretable. A separate BASIS and K-TEA spelling dimension does not appear to exist. This is not surprising since the ability to spell depends heavily upon many of the same skills employed in reading. These findings suggest that the two tests are essentially unidimensional, and therefore, results of the present study failed to find the underlying structure hypothesized by the test authors. As Lewandowski (1986) suggested in his critique of the K-TEA, further research to confirm existence of various subtests appears to be needed.

Salvia and Ysseldyke (1981) report that many researchers have obtained evidence that achievement tests

often measure one underlying construct. This construct apparently taps many skills, abilities, and environmental factors--such as reliance on verbal skills, motivation, overall ability to learn, study skills, and incentive. Often the underlying construct in achievement testing seems to be measuring aspects of overall intelligence which are reflected in the ability to learn. For example, the K-TEA manual reports coefficients of .56 (ages 6 to 8) and .67 (ages 9 to 12) between the K-ABC Mental Processing Composite, which puports to measure global intelligence, and the K-TEA Battery Composite, which measures overall academic achievement. Also, high correlations typically exist between conventional I Q test scores and measures of academic achievement (Kaufman & Kaufman, 1985). Perhaps the strong achievement factor identified in the present study is measuring such a construct. In order to verify this contention, validation studies of the BASIS and K-TEA against recognized achievement tests should be undertaken.

Another plausible hypothesis explaining the unifying factor which seems to underlie the BASIS and K-TEA achievement tests is a reading dimension. Reading skills are heavily employed in reading, spelling, and mathematics word problems and are employed in mathmatics calculations which require related skills such as alignment and symbol interpretation. In the present study, the first canonical root appears to measure a verbal achievement dimension since, even though BASIS mathematics loads with the verbal variables, this mathematics variable measures a dimension which, as already has been established, also may contain verbal components.

Since all three BASIS subtests loaded with the first root, results indicate that the BASIS is more one-dimensional than the K-TEA. The K-TEA exhibited greater independence between subtests than did the BASIS in that K-TEA mathematics subtests loaded on a separate variate. The Basis mathematics grade-referenced cluster, which determines the criterion for each succeeding level, includes only eight problems--six calculation problems and two word problems with the ceiling being reached when the child misses five of the six problems. Not only are separate subtests for Mathematics Applications and Mathematic Computation included in the K-TEA but each subtest includes a larger number of problems, and the ceiling of six consecutive errors is much harder to reach. In other words, the structure of the K-TEA appears to be superior to that of the BASIS in that the first and second roots of the cannonical analysis seem to identify separate K-TEA verbal and mathematics dimensions, although the mathematics dimension is weak and overlap with the first variate exists. These results seem to indicate that the K-TEA may be somewhat superior to the BASIS.

The small, restricted sample of this study is not representative. Consequently, results may reflect the

restricted range in performance rather than a deficiency in the tests themselves. Children with learning problems are often deficient in reading skills which might explain why results of the present study measured a predominant verbal dimension. The range of school grades (first through eighth) is another factor which may influence the validity of the results. The constancy of intelligence in children is influenced by age and, as the child matures, IQ scores become more stable (Sattler, 1982). Therefore, measurement of ability in seventh and eighth grade children should be more stable than in primary grade children.

While a superficial analysis of results seems to show that the underlying structure of the two tests does not reflect that hypothesized by test authors, consideration of such factors as the restricted range of talent, grades, and IQ in the study sample suggests that further research should be conducted in order to resolve the issues raised by findings of this study. Specifically, studies should include larger samples which are more representative of the population by grade and previous school achievement.

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